

III. "On Lesions of the Nervous System producing Diabetes."

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(Abstract.)

The author commenced his paper by stating, that all the experiments he had performed since his communication on the "Alleged Sugar-forming Function of the Liver" had been placed in the possession of the Royal Society, had confirmed the conclusions he had there arrived at. As far as his knowledge extended, it might be said that in the healthy liver during life there is a substance which he had spoken of under the term of hepatine, and which possesses the chemical property of being most rapidly transformed into sugar when in contact with nitrogenized animal materials. In the liver after death this transformation takes place, but in the liver during life there seems a force or a condition capable of overcoming the chemical tendency to a saccharine metamorphosis.

Experiments are mentioned to show that when the medulla oblongata is destroyed, and the circulation is maintained by the performance of artificial respiration, the sugar formed in the liver as a *post-mortem* occurrence is distributed through the system, and occasions the secretion of urine possessing a strongly saccharine character.

Although the destruction of the medulla oblongata leads to this effect, yet division of the spinal cord, which has been practised as high as between the second and third cervical vertebræ, has not been attended with a similar result. The brain (cerebrum) has also been separated from the medulla oblongata by section through the crura cerebri, and from the results of the experiments in which this operation has been performed, Dr. Pavy believed that the functions of the brain may be completely destroyed, without placing the liver in the condition noticeable after actual death, or after lesion of the medulla oblongata. On account of the accidental disturbances,—such as implication of the medulla oblongata, possibly by concussion, obstruction of the respiration, and the effects of the great loss of blood sometimes attending division of the crura cerebri,—the interpretation of the result is rendered a little difficult. In an experiment, which proved most conclusive, performed to corroborate the author's previous observations

whilst his communication was being written, there were none of these disturbing circumstances. In a healthy dog, during a period of digestion, the *crura cerebri* were completely divided. The animal was thereby thrown into a state of unconsciousness, but breathed efficiently of its own accord. The urine in an hour and a quarter's time was found perfectly free from sugar.

After poisoning by strychnine, the effect is the same as after destruction of the *medulla oblongata*. The circulation being maintained by artificial respiration, the urine becomes strongly saccharine.

Looking to these facts, and to the effect of Bernard's puncture of the fourth ventricle in producing diabetes, the author is led to regard the *medulla oblongata* as a centre, either directly presiding over the functional activity of the liver, or indirectly affecting it by altering through the medium of another or other organs the condition of the blood going to it; and he has endeavoured to establish upon positive grounds the channel by which the propagation of the nervous influence may take place. It was this line of research that conducted to the discovery of the strongly diabetic effect produced by dividing certain parts of the sympathetic.

The *medulla oblongata* being thus presumed to form a centre giving to the liver a force which prevents the saccharine metamorphosis of its hepatine, experiment had already shown that it cannot be through the spinal cord or the pneumogastrics separately, that the transmission of nervous influence takes place. But an experiment was performed to determine the effect of dividing both the spinal cord and the two pneumogastrics together. The cord was crushed between the third and fourth cervical vertebræ, and about half an inch of each pneumogastric was cut away from the centre of the neck. Artificial respiration was performed to keep up the circulation. The urine remained entirely free from sugar, and the liver was found in an exsaccharine state at the moment of discontinuing the respiration, and became strongly saccharine afterwards.

On next dividing all the nerves in the neck, an operation effected by performing decapitation, the result that followed after three quarters of an hour's artificial respiration was strongly saccharine urine. After this experiment, and that of division of the spinal cord and pneumogastrics, reason was afforded for looking to the sympathetic; and from the experiments that have been made and are described,

the following conclusions have been arrived at. The animal selected for observation has been the dog, subsisting upon an animal diet, and operated upon at a period of full digestion.

“Division, on both sides of the neck, of the ascending branches of the superior thoracic ganglion which run up towards the canal formed by the foramina in the transverse processes of the vertebræ, for the vertebral artery, occasions an intensely marked diabetes. The urine has been found most strongly saccharine within even half an hour after the operation. The diabetic condition is only of a temporary character, passing off by the next day, and fatal pleurisy is always induced.

“Division of the ascending branches of the superior thoracic ganglion on one side of the neck only, has occasioned merely the presence of a trace of sugar in the urine in an hour and a half’s time. The same operation then performed on the other side has produced in half an hour’s time an intensely saccharine urine.

“*Carefully* ligaturing the two vertebral and the two carotid arteries does not lead to saccharine urine ; but when the carotids have been tied, and the tissue in connexion with the vertebrals before their entrance into the canals is a little roughly treated, without however dividing the larger sympathetic filament ascending from the superior thoracic ganglion, the urine is rendered rapidly and strongly saccharine.

“Division of the sympathetic filaments that have entered the canals does not alone produce diabetes ; but if the contents of these canals be divided, and the carotid arteries at the same time ligatured, saccharine urine is the result.

“This result is produced when the contents of the osseous canals are divided as high as the second cervical vertebra. It has also arisen after destroying the structures in the neighbourhood of the vertebral foramen on the posterior surface of the transverse process of the atlas, but has not yet been noticed after a similar operation on the anterior surface of the process.

“Dividing the contents of the canals and the tissue in immediate contact with the carotid vessels has not produced diabetes ; but when the carotids have been afterwards tied, strongly saccharine urine has resulted.

“Of all the operations on the sympathetic of the dog that have yet

been performed, removal of the superior cervical ganglion the most rapidly and strongly produces diabetes. After the removal of one ganglion, the urine has been found intensely saccharine in an hour's time, and the saccharine character has remained during the following day, but has disappeared by the next. Subsequent removal of the other ganglion a few days later has been followed in half an hour's time with a strongly marked diabetic effect, which, however, has been again only of a temporary nature.

"Division of the sympathetic in the chest has been several times succeeded by saccharine urine. In one case after division on one side only, the urine was intensely saccharine in half an hour's time. On the other hand, many experiments have been made where both sides have been operated on, and only a merely traceable, or in a few instances, even no effect, has been noticeable.

"In the rabbit, removal of the superior cervical ganglia, when the animal is in a strong and healthy state, is followed by diabetes; but the effect is not so rapidly produced as in the dog. It has been noticed at the end of four hours after the operation, and has been observed to exist until the following day.

"Excision of the superior cervical ganglia in the rabbit with a division of the pneumogastrics above their gangliform enlargement close to their exit from the skull, has been attended with the production of saccharine urine in a shorter space of time than when the ganglia alone have been removed, notwithstanding that division of the pneumogastrics in the situation referred to, has not been seen by itself to cause any positive effect."

Such is a simple statement of the principal conclusions derivable from the author's experiments, which are given in detail in his communication. As to the interpretation of the results that have been obtained, this he leaves for further investigation, in which he is now engaged, if possible, to disclose. The experiments on the sympathetic were commenced under the notion that it might form the medium of transmission of nervous force from the medulla oblongata to the liver. From this supposition certain facts have been discovered which are left for the present, without discussing whether the notion that led to them is right or wrong.